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L6: Entry 4 of 4

File: USPT

May 22, 1990

DOCUMENT-IDENTIFIER: US 4927540 A

** See image for Certificate of Correction **

TITLE: Ionic complex for enhancing performance of water treatment membranes

Brief Summary Text (6):

A coating system which enhances or restores performance of reverse osmosis membranes has long been sought. U.S. Pat. No. 3,877,978 describes the use of certain vinyl acetate copolymers to improve rejection of membranes. U.S. Pat. No. 3,886,066 discloses the use of hydrolyzable tannins to reduce solute passage of reverse osmosis membranes. U.S. Pat. No. 4,214,020 claims a process for coating membranes assembled in devices.

Brief Summary Text (38):

Conveniently, the coating formulations are applied to the substrate by conventional techniques, such as dipping, casting, spraying, wiping, rolling or filtration of the coating solution through the substrate. The excess coating is desirably removed by draining or drawing a smooth instrument, e.g., a blade or roller, across the substrate surface. Multiple coats can also be applied to eliminate defects. The temperature and pH of the coating solution are selected so as to maintain the desired ionic moiety's concentration in the coating formulation and afford the desired film-forming properties. These operating parameters are generally not critical so long as the resulting membrane is not deleteriously affected. Ambient temperatures during coating, i.e., about 20.degree. to 35.degree. C., are generally convenient, although other temperatures are operable. A pH in the range from about 7.0 to about 7.8 is preferred for vinyl acetate/crotonic acid copolymers. A pH of from about 6.0 to about 7.5 is preferred for polymeric siloxanes bearing quaternary ammonium groups.

Brief Summary Text (47):

The ionic complex can be used to form or enhance performance of reverse osmosis membranes of the nanofiltration, low pressure brackish water, standard pressure brackish water or seawater type. Nonofiltration membranes generally have a nominal rejection of at least about 85 percent of a 2,000 ppm MgSO₄ solute at 50 psi. The brackish water membranes have a rejection of at least about 90, preferably at least about 95 percent of a 1,500 ppm NaCl solution at 250 psi for low pressure membranes and 400 psi or standard pressure membranes. The seawater membranes have a nominal rejection of at least about 95, preferably at least about 98, percent of a 35,000 ppm NaCl solution at 800 psi.

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L6: Entry 3 of 4

File: USPT

Mar 19, 1996

DOCUMENT-IDENTIFIER: US 5500124 A

TITLE: Process for the purifying working-up of reaction media and/or wash media obtained during preparation of cellulose ethers

Brief Summary Text (5):

JP-OS-82/68190 describes a process for the purification of wastewater, which contains nonionic dissolved cellulose ethers, by flocculation with phenolic compounds, such as phenol or tannin. In this process, however, a COD caused by excess flocculating agent remains in the wastewater. This residual COD is removed from the wastewater by oxidation with a chlorine-containing oxidizing agent, such as chlorate or sodium hypochlorite, the formation of AOX (adsorbable organic halogen compounds) resulting from the use of these chlorine-containing oxidizing agents.

Brief Summary Text (29):

A further reduction in the COD is possible by a subsequent nanofiltration.

Brief Summary Text (31):

The constituents which can be degraded biologically only slowly and are contained in the concentrate can also be largely removed from the concentrate by addition of flocculating agents or by addition of cellulose ethers which are insoluble in hot water. The addition of flocculating agents or cellulose ethers is advantageously carried out at a temperature above the flocculation temperature of the cellulose ethers, preferably at a temperature above 60.degree. C. Suitable flocculating agents are, preferably, naturally occurring tanning agents, such as tannin and quebracho, and/or commercially available synthetic products, such as phenol condensation products or naphthol/phenol condensation products.

Brief Summary Text (33):

The amount of flocculating agents added depends on the amount of organic constituents contained in the concentrate and is, for example, advantageously in the range from 1000 to 1400 mg/g of organic constituents for tannin. It has also been found that merely increasing the temperature of the UF concentrate, without addition of flocculating agents or cellulose ethers, leads to flocculation of previously dissolved organic constituents.

Brief Summary Text (37):

The permeates can be further purified by nanofiltration at a temperature of the reaction medium or wash medium above the flocculation temperature of the cellulose ether.

Brief Summary Text (38):

By nanofiltration there is to be understood a membrane separation process which operates in the transition region from ultrafiltration reverse osmosis. It is chiefly used for removal of low molecular weight organic substances from salt-containing solutions.

Brief Summary Text (40):

The concentrate from the nanofiltration is preferably passed to the UF concentrate, and with this to the flocculation step described. The permeate from the

nanofiltration is removed to a biological clarification plant.

Brief Summary Text (41):

It has been found that the same materials and units such as are used in the ultrafiltration are suitable for the nanofiltration, but as a rule a higher pressure level is to be maintained and denser membranes are employed.

Detailed Description Text (11):

A washwater from the preparation of methylhydroxyethylcellulose, under a load of 13700 mg of COD/l, was pumped through an ultrafiltration cell for reduction of the COD. The ultrafiltration was carried out under an operating pressure of 5 bar at an operating temperature of 70.degree. C. The permeate obtained under these conditions was now loaded with only 7790 mg of COD/l. The permeate throughput dropped from 46 l/m.sup.2 h to 23 l/m.sup.2 h during the filtration operation.

Detailed Description Text (25):

A washwater from the preparation of methylhydroxyethylcellulose was divided into a permeate depleted in COD and a concentrate enriched in COD with the aid of ultrafiltration at 70.degree. C. In comparison with the washwater, the COD in the concentrate was increased by 5760 mg of O.sub.2 /l. The COD carriers enriched by the ultrafiltration, which resulted in an increase in the COD, were to be flocculated virtually completely by addition of 4.2 g of pure tannin (DAB 7) to the concentrate. A polysulfone membrane from Hoechst AG (Nadir.RTM. PS 100) was used for the ultrafiltration.

Detailed Description Text (33):

A permeate having a COD of 8600 mg of O.sub.2 /l was obtained from a washwater from the preparation of methylhydroxyethylcellulose by ultrafiltration at 70.degree. C. For further reduction in the COD, this permeate was subjected to a nanofiltration. A flux of 125 l/m.sup.2 h was established under an operating pressure of 30 bar at an operating temperature of 72.degree. C. The filtrate obtained from the nanofiltration under these conditions was depleted in COD by 24% compared with the UF permeate

CLAIMS:

4. The process as claimed in claim 3, wherein the natural occurring tanning agent is vegetable tannin.
8. The process as claimed in claim 1 wherein the permeate obtained during the ultrafiltration is purified by nanofiltration.
14. The process as claimed in claim 1, wherein the permeate obtained during the ultrafiltration, with an ultrafiltration membrane, is optionally purified by nanofiltration, with a nanofiltration membrane, and wherein, during the ultrafiltration and/or the nanofiltration, the shearing forces on the ultrafiltration and/or nanofiltration membrane surface or surfaces are increased beyond the extent determined by the volume throughput.

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L2: Entry 19 of 55

File: USPT

May 7, 2002

US-PAT-NO: 6383392

DOCUMENT-IDENTIFIER: US 6383392 B1

** See image for Certificate of Correction **

TITLE: Process for concentrating epigallocatechin gallate

DATE-ISSUED: May 7, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Bonrath; Werner	Freiburg			DE
Burdick; David Carl	Binningen			CH
Schirg; Peter	Badenweiler			DE
Thum; Andreas	Ulm			DE

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Roche Vitamins, Inc.	Parsippany	NJ			02

APPL-NO: 09/ 709123 [PALM]

DATE FILED: November 8, 2000

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
EP	99122753	November 16, 1999

INT-CL: [07] B01 D 61/00

US-CL-ISSUED: 210/652; 210/650, 210/651, 426/271, 426/330.3, 426/425

US-CL-CURRENT: 210/652; 210/650, 210/651, 426/271, 426/330.3, 426/425

FIELD-OF-SEARCH: 210/652, 210/651, 210/805, 210/195.2, 210/650, 426/271, 426/330.3, 426/425

PRIOR-ART-DISCLOSED:

U. S. PATENT DOCUMENTS

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PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
<input type="checkbox"/> <u>5587083</u>	December 1996	Twardowski	
<input type="checkbox"/> <u>5879733</u>	March 1999	Ekanayake et al.	

6068862 May 2000 Ishihara et al.
 6268009 July 2001 Ekanayake et al.

FOREIGN PATENT DOCUMENTS

FOREIGN-PAT-NO	PUBN-DATE	COUNTRY	US-CL
WO 99/08693	February 1999	WO	

OTHER PUBLICATIONS

Derwent English language abstract of JP 06256201 (1994).
Derwent English language abstract of JP 06116258 (1994).
Derwent English language abstract of JP 02184626 (1990).
Derwent English language abstract of JP 01299224 (1990).
Derwent English language abstract of JP 62030711 (1987).

ART-UNIT: 1761

PRIMARY-EXAMINER: Fortuna; Ana

ATTY-AGENT-FIRM: Bryan Cave, LLP

ABSTRACT:

The present invention is a process for concentrating aqueous epigallocatechin gallate (EGCG) solutions by feeding an aqueous EGCG solution to at least one membrane module under pressure to provide a permeate purge and a retentate return so that in the latter the concentration of EGCG is increased. The permeate purge and the retentate return are then collected.

13 Claims, 1 Drawing figures

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10/28
1997*

L2: Entry 21 of 55

File: USPT

Mar 12, 2002

date not good

DOCUMENT-IDENTIFIER: US 6355110 B1

TITLE: Process for purification of low grade sugar syrups using nanofiltration

Detailed Description Text (24):

Nanofiltration membranes for use in the present invention preferably have a molecular weight cutoff of about 100-500 Daltons, more preferably about 150-300 Daltons, and a magnesium chloride rejection of 96%. Suitable ultrafiltration membranes preferably will have a molecular weight cutoff of about 2000-100,000 daltons. Suitable microfiltration membranes preferably will have a pore size of about 0.02-0.2 microns. Suitable membrane systems are available from manufacturers such as Koch Membrane Systems, Wilmington, Mass. (USA); Osmonics/Desal, Vista, Calif. (USA); Dow Chemical Company, Midland, Mich. (USA); and SCT Membralox (France).

Detailed Description Text (29):

The nanofiltration equipment comprised two 4-inch spiral modules in series, and the membrane used was a Desal 5. The manufacturer of this membrane is Osmonics/Desal of Vista, Calif., USA. The membrane is designed to operate at 35 bar and the feed pump 252 was set to produce this pressure. The re-circulation pump 258 was set to give a pressure across the membrane modules of 12 psi.

Detailed Description Text (55):

The nanofiltration membrane used in all of the above examples was a Desal 5. Other nanofiltration membranes that can be used are Hydranautics NTR 7450, AMT ATP 50 or ASP 50, or Dow NF 45.

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L2: Entry 20 of 55

File: USPT

Apr 23, 2002

DOCUMENT-IDENTIFIER: US 6375751 B2

TITLE: Process for production of purified cane juice for sugar manufacture

*date not good to record
10/28
1997*

Detailed Description Text (36):

In this test a spiral membrane was used rather than a tubular membrane. The juice fed to the membrane was the same as in Example 1.

Detailed Description Text (38):

Manufacturer: DESAL

Detailed Description Text (39):

Membrane Type: Spiral

Detailed Description Text (51):

Membrane Type: Spiral

Detailed Description Text (65):

Membrane Type: Spiral

Detailed Description Text (78):

Membrane Type: Spiral

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L2: Entry 29 of 55

File: USPT

Jun 6, 2000

date not good

DOCUMENT-IDENTIFIER: US 6071413 A

** See image for Certificate of Correction **

TITLE: Process for removing organic and inorganic contaminants from phenolic stripped sour water employing reverse osmosis

Detailed Description Text (13):

In general, the reverse osmosis membrane 34 can be formed into any suitable configuration such as a flat sheet, hollow fiber and the like, employing known methods. As one skilled in the art will readily appreciate, the flat sheet can be further formed into a configuration such as a spiral wound module or a plate-and-frame. A preferred configuration for use herein is the spiral wound module. The reverse osmosis membrane 34 possessing a spiral wound module configuration used herein will ordinarily have a diameter of about 8 inches and a length of about 40 inches. The reverse osmosis membrane 34 can typically process about 5 gallons/minute of pH adjusted reverse osmosis sour water 32 at a pressure differential maintained across the membrane 34 from about 200 to about 1,000 psig. A full scale operation can use multiple larger membranes having a commercially available diameter of at least about 8 inches and a length of at least about 60 inches. The reverse osmosis membrane 34 at full scale operation can ordinarily process about 7.5 gallons/minute of pH adjusted reverse osmosis sour water 32 at a pressure differential of from about 200 to about 1,000 psig.

Detailed Description Text (27):

Invention Demonstration Test (March-April 1995) 80% RECOVERY-pH 10.1-DESAL

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L2: Entry 37 of 55

File: USPT

Mar 30, 1999

*not used to
filter Tannin*

DOCUMENT-IDENTIFIER: US 5888401 A

TITLE: Method and apparatus for reducing membrane fouling

Detailed Description Text (16):

The methods of the invention can be used, for example, for microfiltration, ultrafiltration, nanofiltration or reverse osmosis. The methods of the invention can be used, for example, with dissolved or insoluble, suspended solids. Additionally, the methods of the invention can be used, for example, with diafiltration or tangential (cross-flow) filtration. Further, the methods of the invention can be used with asymmetric or symmetric membranes and with composite membranes having more than one layer or membranes having only one layer. The methods of the invention can be used, for example, with membranes made of ceramic or a polymeric material, such as polystyrene, polyester, polyamide, polysulfones or cellulose acetate. Further, the methods of the invention can be used, for example, with multiple membranes. In preferred embodiments, the methods of the present invention are used in the pulp and paper industry, and the membrane is preferably made of a polysulfone material, such as the membranes provided by Desal, for instance, the Desal DL membrane (San Diego, Calif.) or the polyamide membranes provided by Trisep (San Diego, Calif.), such as the ACM4 or TS40 membranes.

Detailed Description Text (17):

The membrane unit construction can comprise, for example, tubes, plates or hollow fibers, or it can be spiral-wound. In certain preferred embodiments, the membrane unit comprises a plate and frame system with a spacer or frame between membranes that are supported by a support plate.

Detailed Description Paragraph Table (1):

Solution	Cleaning Temp.	Duration	Type of Cleaning	pH	Process	Membrane	River
TriSep Micro	pH 11 80.degree. F.	1 min	ACM4 Whitewater DL, <u>Desal</u> Micro	pH 11 120.degree. F.	1 min Bleach DL, <u>Desal</u> Micro	100.degree. F.	1 min Secondary TS40, Micro, pH 12 80.degree. F. 2 min Treatment TriSep pH 12 Effluent Primary TS40, Micro, pH 12 90.degree. F. 1 min Treatment TriSep pH 12 Effluent

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L2: Entry 42 of 55

File: USPT

Oct 28, 1997

*not used for
Tanner
used for protein*

DOCUMENT-IDENTIFIER: US 5681728 A

TITLE: Method and apparatus for the recovery and purification of organic acids

Detailed Description Text (7):

In accordance with the present invention, these feed materials can be subjected to nanofiltration using at least one nanofiltration filter material. Such nanofiltration filter materials include, but are not limited to, ceramic membranes, metal membranes, polymer membranes and composite membranes. It is desirable that such membranes are capable of removing from the feed material at least a portion of any multivalent compounds and proteinaceous materials which may be present in the feed material. It is also desirable that the nanofiltration filter material be capable of removing at least a portion of any sugars and polysaccharides that may be present in the feed material. These nanofiltration filter materials can be used in a variety of configurations, including, but not limited to, hollow fiber membranes, tubular membranes and spiral wound membranes. The nanofiltration filter materials useful in the present invention typically have average pore sizes within the range of from about 1 nm to about 5 nm, preferably in the range of from about 1 nm to about 2 nm and more preferably in the range of from about 1 nm to about 1.5 nm.

Detailed Description Text (8):

Although it is not fully understood, it is believed by the inventors that the effectiveness of the nanofiltration filter material to remove impurities such as multivalent compounds and proteinaceous materials is based upon both the pore size characteristics of the nanofiltration filter material and the surface chemistry of the nanofiltration filter material. Accordingly, it is desirable to use a nanofiltration filter material having surface chemistry characteristics which enable the nanofiltration filter material to prevent at least a portion of any multivalent compounds and other charged impurities which may be in the feed material from passing through the membrane during nanofiltration. Preferred for use as nanofiltration filter materials in the present invention are composite membranes which have a negatively charged thin-film separation layer deposited on a base film. It is to be understood, however, that selection of acceptable and preferred nanofiltration filter materials can depend upon the organic acid or organic acid salt being concentrated, purified or separated. Accordingly, preferred for use in the present invention as nanofiltration filter materials when lactic acid or lactic acid salts are being concentrated, purified or separated are materials made of cellulose acetate, polyamides, polyvinyl alcohols, polysulfones, polyether sulfones, polyesters, polyureas, polyamines and ceramics. Even more preferred for use in the present invention as nanofiltration filter materials when lactic acid or lactic acid salts are being concentrated, purified or separated are DESAL-5, obtained from Desalination Systems, Inc., Escondido, Calif. and "FILM-TEC" NF-45 obtained from Dow Chemical, Minneapolis, Minn.

Detailed Description Text (49):

The fermentation medium was filtered using a 0.1 .mu.m ceramic filter to remove the cell mass. A five gallon sample of the clarified ammonium lactate solution was sent to Niro Hudson Filtration Co. in Wisconsin for batch nanofiltration trials using Desal-5 and "FILM-TEC" NF-45 nanofiltration membranes simultaneously. The feed was first subjected to nanofiltration using the NF-45 nanofiltration membrane. The

permeate was analyzed and the results are set forth in Table 1. The retentate from the NF-45 nanofiltration membrane was then subjected to nanofiltration with a Desal-5 nanofiltration membrane. The experimental results are summarized below in Table 1.

Detailed Description Paragraph Table (1):

TABLE 1 Experimental Results of
Nanofiltration With NF-45 and Desal-5 Nanofiltration Membrane PROTEINS SAMPLE
SAMPLE Mg (ppm) (g/L)* COLOR FEED 181.4 1.76
BROWN NF-45 4.4 0.38 COLORLESS Desal-5 126.4 0.95 LIGHT BROWN RETENTATE 642.9 10.7
DEEP BROWN *Protein concentrations were
determined by the Lowry assay.

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L2: Entry 47 of 55

File: USPT

Jan 16, 1996

DOCUMENT-IDENTIFIER: US 5484594 A

TITLE: Process for preparing grapeseed extracts enriched in procyanidol oligomers

Brief Summary Text (23):

E) Ultrafiltration of the permeate from step D), from which the high molecular weight substances have been removed, through coiled-spiral membranes of cut-off 3.000 to 600.

Brief Summary Text (25):

The permeate from step D) above, before the final purifications, no matter how they are carried out, still contains monomeric substances: in the case of *Vitis vinifera* (+)-catechin and (-)-epicatechin and, in lower amounts, undesired polymeric substances. In order to obtain a good demonomerization degree, the more convenient process comprises a further ultrafiltration on coiled-spiral membranes of cut-off 600 to 3,000 and counter-extraction of the concentrate with ethyl acetate.

Detailed Description Text (3):

100 kg of *Vitis vinifera* grapeseeds are soaked in 150 l of acetone containing 20% water, at room temperature. The extraction solvent is filtered and the extraction is repeated for 4 times more or until exhaustion in phenol derivatives, checking with FeCl_3 an aliquot of the extract until the total solids contain less than 0.05% of phenol derivative. The aqueous acetone solutions are combined, acetone is evaporated off by distillation under vacuum until the organic solvent is completely removed. At the end of the concentration, an abundant precipitate forms which, after standing in refrigerator at 4. degree. C. for 24 hours, is centrifuged to give a solid material which comprises lipophilic products and a highly polymerized tannic material. The aqueous solution (about 40 l) is adjusted to pH 6 with 40% NaOH, under nitrogen, and ultrafiltered on a tubular membrane of cut-off 100,000 Enichem (UF-100F), at a temperature below 20. degree. C., and dialyzed with 57 l of water. The permeate, from which polymers have been removed, is acidified with 25% H_2SO_4 to pH 3.5 and concentrated by reverse osmosis with coiled-spiral membrane Desal B241-111 until a 30% total solids is obtained. The aqueous concentrate is extracted continuously with an ethyl acetate toluene 8:2 (v/v) mixture by means of a liquid/liquid centrifuge separator until exhaustion of monomeric substances. The exhausted solution is extracted continuously with ethyl acetate until exhaustion of oligomers. The organic phase is concentrated under vacuum to 1.5 liter and diluted with 4.5 l of methylene chloride. The precipitate is centrifuged and dried for 24 hours at 50. degree. C. under vacuum: yield 0.42 kg. This purified extract contains the monomeric substances in a 1 to 1% amount.

Detailed Description Text (5):

100 kg of *Vitis vinifera* grapeseeds are extracted according to the procedure of Example 1. The permeate, after ultrafiltration on a tubular membrane with cut-off 100,000 (Enichem UF-100F) is acidified to pH 3.5 and ultrafiltered on a coiled-spiral membrane Desal U20-G20 and the solution is dialyzed with 20 volumes of water with respect to the starting solution volume. The concentrate from which the monomeric substances have been removed is further concentrated to a 30% total solids. The aqueous concentrate is extracted with ethyl acetate until exhaustion of the oligomers; the organic phase, after concentration to 1.5 l, is poured into 4.5 l of methylene chloride. The precipitated oligomers are filtered and dried at

50.degree. C. for 24 hours, to obtain 0.45 kg of the same final product as in Example 1.

Detailed Description Text (8):

The aqueous solution at pH 3.5 can be subjected either to the treatment reported in Example 1, using tubular membranes of cut-off 100,000 and reverse osmosis, or to a treatment according to the procedure of Example 2, with a membrane of cut-off 100,000 and a coiled-spiral membrane Desal U20-G20. The concentrated aqueous solutions are treated according to the procedures of Examples 1 and 2.

Detailed Description Text (17):

100 kg of *Vitis vinifera* grapeseeds are extracted according to the procedure of Example 2. The permeate from the coiled-spiral membrane Desal U20-G20 of Example 2 and/or the aqueous solution obtained from the ethyl acetate/toluene 8:2 mixture according to the procedure of Example 1, after concentration to a pasty residue and substitution of the solvent with water, are ultrafiltered on a coiled-spiral membrane U20-G5. The concentrated aqueous solution, after dialysis, is nearly free of monomers and contains the oligomers which are extracted with ethyl acetate. The organic solution is concentrated to 0.1 liter and precipitated with 0.5 l of methylene chloride.

CLAIMS:

4. The process as claimed in claim 1 wherein tubular, capillary, coiled-spiral or plane membranes are used for the ultrafiltration.

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L6: Entry 2 of 4

File: USPT

Oct 27, 1998

DOCUMENT-IDENTIFIER: US 5827560 A

TITLE: Process for producing cold water soluble tea extract

Abstract Text (1):

A continuous process for producing a tea extract which contains solubilized tannins and which has good color. Tea solids are extracted from tea leaves using an extraction liquid to provide a tea extract containing soluble tea solids and insoluble tannins. The insoluble tannins are separated from the tea extract and oxidized and solubilized under raised temperature conditions to provide a solubilized tannin liquor. The solubilized tannin liquor is either returned to the extraction liquid during extraction of tea solids or added to the tea extract after separation of the insoluble tannins. The tea extract which contains solubilized tea tannins is collected.

Brief Summary Text (2):

This invention relates to a process for producing a tea extract in which insoluble solids, for example tannins, are solubilized to improve the cold water solubility of these insoluble solids. The invention also relates to tea extracts and to tea products produced using the process.

Brief Summary Text (4):

Aqueous extracts obtained from tea contain a number of solids, of which some are soluble in hot water only. An example is the tannin fraction which contains polyphenolic compounds and complexes of polyphenolic compounds with other compounds. For convenience and because it is customary in the art to do so, these cold-water, insoluble solids are referred to in this specification as "tannins"; even though they might not all be tannins in a strict chemical sense. These solids are also known in the art as "tea creams". When cold water beverages are prepared from tea, the tannins usually precipitate out; forming undesirable layers and also turning the beverage cloudy. Cloudy beverages are usually unacceptable to consumers.

Brief Summary Text (5):

One attempt to deal with the problem has been to simply remove the tannins from the tea extract prior to further processing of the extract. Although this solves the problem, it creates others. In particular, since the tannins provide a substantial part of the overall flavor of the tea beverage, beverages produced from the tannin-depleted extract lack flavor. Also, the tannins contain high concentrations of matter which provide the tea extract with color. Therefore tannin depleted extracts usually have an unacceptably light color.

Brief Summary Text (6):

Another approach has been to remove the tannins from the tea extract, solubilize them to make them soluble in cold water, and then return them to the extract. One example of this approach is described in U.S. Pat. No. 3,163,539. Here the tannins are first removed from the tea extract by cooling of the extract to precipitate the tannins. The tannins are then subjected to oxidation under highly basic conditions. Thereafter, the treated tannins are recombined with the tea extract from which they were removed. The mixture is then acidified to return it to the normal pH of an untreated tea extract. The mixture is then processed as usual into tea powder or a

tea concentrate in which the solids are soluble in cold water. The problem with this approach is that residues of the alkali and acid used in the process are present in the final product. These residues are undesirable in foodstuffs.

Brief Summary Text (7):

To get around this problem, it has been suggested in U.S. Pat. No. 3,787,590 that the use of an oxidizing agent in the oxidation step avoids the need to raise the pH of the tannins. The oxidizing agents suggested are hydrogen peroxide, ozone, oxygen, mixtures of these gases with air, and the like. This process has also been improved upon, as is described in U.S. Pat. No. 4,156,024, by the use of an oxidation catalyst in conjunction with the oxidizing agents. However for both processes, it has been found that, during oxidation, acidic substances are produced which reduce the efficiency of these processes since the oxidation of tea tannins is a base catalyzed reaction. Hence, small amounts of base must still be added when the processes are used commercially; which again must be neutralized. Therefore these processes, although reducing the amounts of acid and base used, do not do away with their use completely.

Brief Summary Text (8):

It is therefore clear that a need exists for a process of producing a tea extract containing solubilized tannins which is simple, effective, and which produces a product which has little or no unnatural contaminants and which has acceptable color.

Brief Summary Text (10):

It is therefore an object of this invention to provide a process for producing a tea extract of acceptable color which contains solubilized tannins and which does not require the use of basifying or acidifying agents.

Brief Summary Text (11):

Accordingly, in one aspect, this invention provides a process for producing a tea extract which contains solubilized tannins, the process comprising:

Brief Summary Text (12):

i) extracting tea solids from tea leaves using an extraction liquid to provide a tea extract containing soluble tea solids and insoluble tannins;

Brief Summary Text (13):

ii) separating the insoluble tannins from the tea extract to obtain clarified tea extract;

Brief Summary Text (14):

iii) oxidizing and solubilizing the tannins under raised temperature conditions to provide a solubilized tannin liquor; and

Brief Summary Text (15):

iv) adding the solubilized tannin liquor to the extraction liquid during extraction of tea solids from tea leaves in step i), or to the clarified tea extract of step ii) to obtain a fortified tea extract and separating insoluble tannins from the fortified tea extract to obtain a clarified tea extract; and

Brief Summary Text (16):

v) collecting the clarified tea extract of step ii) or step iv) to obtain a tea extract which contains solubilized tea tannins.

Brief Summary Text (17):

It is surprisingly found that by oxidizing the insoluble tannins and then returning the solubilized tannins to the extraction process or to the clarified tea extract, a tea extract may be obtained which contains solubilized tannins but little or no insoluble tannins. Also the tea extract has a good flavor. Further, no chemical

acidifying or basifying agents are used and hence the tea extract does not contain contaminants. Moreover, the solubilized tannins have a dark red color so that the tea extract better approximates the color of a natural tea beverage. The prior art solubilization processes often produce black tannins which then need to be bleached; further adding to the contamination. Hence the invention provides a significant improvement in the art.

Brief Summary Text (18):

The insoluble tannins are preferably oxidized using a gaseous oxidizing agent so that residues of the agent in the tea extract can be minimized. Suitable examples of gaseous oxidizing agents are ozone, oxygen, and mixtures of these gases with air. Oxygen gas is especially preferred.

Brief Summary Text (19):

The temperature at which the insoluble tannins are oxidized is preferably about 80.degree. C. to about 130.degree. C.; more preferably about 102.degree. C. to about 110.degree. C. The insoluble tannins are preferably oxidized at a pressure of about 1.5 MPa to about 2.0 MPa.

Brief Summary Text (20):

The process may also include the step of adding green tea leaves to the insoluble tannins prior to oxidizing the insoluble tea solids. It is found that the green tea leaves may remove acids during the oxidation reaction and may further increase the yield of solubilized tannins. Preferably the amount of green tea leaves used in the process comprises at least 20%, for example from 20% to 50%, by weight of the total amount of insoluble tannins and green tea leaves combined. More preferably, the green tea leaves comprise from 25% to 40%, particularly 25% to 30%, by weight of the total amount of insoluble tannins and green tea leaves combined.

Brief Summary Text (21):

The process may further comprise the step of removing at least a portion of the acids from the solubilized tannin liquor prior to adding the solubilized tannin liquor to the extraction liquid. The acids may be removed, for example, by ultrafiltration of the solubilized tannin liquor, by steam stripping of the solubilized tannin liquor, or by contacting the solubilized tannin liquor with spent tea leaves. In particular the process may comprise separating solubilized tannin liquor into a first and a second stream, removing acids from the solubilized tannin liquor in the first stream, and combining the first stream with the second stream prior to adding the solubilized tannin liquor to the extraction liquid.

Brief Summary Text (22):

Preferably the tea solids are extracted from the tea leaves in a series of interconnected fixed-bed reactors; the solubilized tannin liquor being added to the extraction liquid between one or more adjacent pairs of fixed-bed reactors of the series.

Brief Summary Text (23):

Preferably the solubilized tannin liquor is added to the extraction liquid immediately prior to the fixed-bed reactor containing the freshest of the tea leaves.

Brief Summary Text (25):

In another aspect, this invention provides a soluble tea powder containing solubilized tannins and which is free of chemical acidifying and basifying agents, the soluble tea powder when dissolved in water at about 10.degree. C. at a concentration of about 0.25% by weight providing a beverage having an NTU of less than about 40 and a color of about 40 to 55 when determined by light transmittance at a wave length of 524 nm.

Brief Summary Text (27):

Embodiments of the invention are now described by way of example only. The process is particularly suitable for producing tea products which contain solubilized tannins obtained from extracts of mixtures of black and green tea; but it may also be used on black tea extracts and oolong tea extracts. Oolong tea is green tea which has been enzymatically oxidized to some extent. Green tea is tea which has been freshly picked and then treated, usually heat treated, to inactivate enzymes in the tea which oxidize the green tea to black tea. Black tea is tea which has been fully enzymatically oxidized.

Brief Summary Text (28):

The extent to which the tannins have been solubilized can be determined by measuring the turbidity of a cold beverage produced from a mixture of the solubilized tannins and soluble tea solids. In producing the cold beverage, the concentration of the mixture of the solubilized tannins and the soluble tea solids is selected to be about 0.25% by weight, which corresponds to the usual concentration of these components in a tea beverage. Also, the ratio of the solubilized tannins to the soluble tea solids is selected to approximate that found in a conventional tea beverage. The temperature of the beverage is set to about 10.degree. C. The turbidity of the beverage is then measured using a suitable turbidimeter, for example a Hatch Ratio Turbidimeter obtainable from the Hatch Company, Loveland, Colo., USA, and the results reported in Nephelometric Turbidity Units (NTU). An NTU value of less than about 40 indicates a beverage containing little or no insoluble tannins.

Brief Summary Text (32):

Another method which is used is that described in U.S. Pat. No. 3,992,983. Here the tea is slurried with hot water and then run through a vertical column which has a perforated circumferential wall. Hot water for extraction is then run down the outside of the perforated column, within a larger column concentric with the perforated column. Solids soluble in hot water, including the tannins, diffuse into the hot water for extraction.

Brief Summary Text (35):

The insoluble tannins are then separated from the soluble tea solids by cooling the tea extract to below about 15.degree. C., usually to about 5.degree. to 10.degree. C. This causes the insoluble tannins to form solid particles which can then be removed by filtration or by settling. The type of separation technique used is not critical and may be selected to give the best economic performance under the conditions chosen. For smaller scale operations, a centrifuge filter usually operates adequately. The filtrate, which is the tea extract produced by the process, usually contains about 6% by weight of soluble tea solids and solubilized tannins.

Brief Summary Text (36):

The insoluble tannins are then collected, if necessary washed, and suspended in water to provide a tannin liquor of a concentration of at most about 15% by weight; preferably less than about 4 to about 5% by weight. The tannin liquor is then subjected to an oxidation reaction under raised temperature and pressure conditions to solubilize the insoluble tannins. The oxidation reaction may be carried out in any reactor suitable for carrying out oxidation reactions at elevated pressures and temperatures. Stirred tank reactors, which have heating jackets, and column reactors are particularly suitable. If the process is a continuous process, a column reactor may be used.

Brief Summary Text (37):

The temperature at which the oxidation reaction is carried out is preferably at least about 80.degree. C., more preferably at least about 100.degree. C.; for example from 102.degree. C. to 110.degree. C. Temperatures less than about 80.degree. C. are not preferred since they lead to incomplete oxidation or prolonged times for complete oxidation. Temperatures greater than about 130.degree.

C. are not preferred since these temperatures, although effective, may cause irreversible denaturation of the tannins.

Brief Summary Text (39):

The amount of the oxygen needed to oxidize the tannins will depend upon the process parameters chosen, the type of tea used, the level of oxidation desired and commercial considerations. However the amount is not critical and is readily determined; particularly since substantially the same amount as used in the art, under similar conditions, may be used. For example, the amount of oxygen introduced may be in the range of about 4 moles of O₂ /kg of tannins to about 18 moles of O₂ /kg of tannins. Usually a small excess of oxygen will be used. For better temperature control, the oxygen gas may be heated to the reaction temperature before being introduced into the reactor.

Brief Summary Text (40):

It will be appreciated that it is not necessary to use oxygen as the oxidizing agent since the choice of oxidizing agent is not critical; any of the oxidizing agents known in the art for oxidizing tannins, such as ozone, mixtures of oxygen or ozone gases with air, and hydrogen peroxide, may also be used.

Brief Summary Text (41):

The residence time of the tannin liquor in the reactor is selected such that sufficient oxidation of the tannins is achieved. Usually a residence time of about 10 minutes to 2 hours is sufficient. For batch reactions, if desired, the progress of the reaction may be monitored so that the reaction may be stopped once adequate oxidation has been achieved. This may be done taking samples of the reaction mixture during the reaction. The samples may then be analyzed to determine the solubility of the tannins, for example. The solubility may be determined by measuring the turbidity of the sample once dissolved in cold water at 10 degree C. and at a concentration of about 0.25% tea extracts. In this way, the optimum reaction time may be determined for each reaction and the reaction time stopped at that point.

Brief Summary Text (42):

If desired, green tea leaves, preferably ground, may be added to the tannin liquor prior to oxidation. It is found that the green tea leaves may assist the oxidation reaction, probably by reducing acid concentration in the tannin liquor. The amount of green tea leaves used preferably falls within the range 20% to 50% by weight of the total amount of tannin in the tannin liquor and the green tea leaves combined. Afterwards, the green tea leaves may be separated off by filtration.

Brief Summary Text (43):

The solubilized tannin liquor may then be subjected to a physical process to remove acids. Although not essential, it is found that these physical processes improve the color of the tea extract. Since the solubilized tannin liquor is recycled into the flow of the extraction liquid, removal of acids from the solubilized tannin liquor results in a reduction of acids in the tea extract. Tea extracts with higher pH's have a darker, more acceptable color.

Brief Summary Text (44):

The acids may be removed in a number of ways. One suitable process is to subject the solubilized tannin liquor to ultrafiltration to collect particles of sizes of less than 1 μ m; preferably of molecular weight less than about 2000; for example about 1000. Suitable ultrafilters are commercially available; for example from Millipore Corp., Desal Systems, etc. By using ultrafiltration in this way, it is found that about 20 to about 30% of titratable acids may be removed. If it is desired to recover most of the tannin solids which pass through the ultrafilter, the permeate from the ultrafiltration may be subjected to nanofiltration to collect particles of molecular weight of about 2 to about 500. Again suitable nanofilters are commercially available; for example from Desal Systems. The retentates from the

ultrafiltration and nanofiltration are then combined. The combination contains substantially all the tannin solids (for example above about 95%) and a reduced amount of titratable acids, on the order of about 15% to about 25%, when compared to the solubilized tannin liquor.

Brief Summary Text (45):

Another suitable physical process to remove acids is to subject the solubilized tannin liquor to steam stripping. This may be done by introducing the solubilized tannin liquor into the top of a suitable stripping column; for example a sieve tray column. Steam is introduced into the bottom of the column and caused to flow counter-current to the solubilized tannin liquor to strip off acids. It is found that both the pH and the concentration of titratable acids in the stripped liquor is reduced.

Brief Summary Text (46):

Yet another suitable physical process to remove acids is to contact the solubilized tannin liquor with of spent tea leaves. It is found that both the pH and the concentration of titratable acids in the filtered liquor is reduced.

Brief Summary Text (47):

The solubilized tannin liquor is then either introduced into the flow of extraction liquid that is being used to extract the tea leaves or is added to the tea extract after separation of the insoluble tannins. Introducing the solubilized tannin liquor into the flow of extraction liquid is particularly suited to extraction processes which use a series of extraction reactors; particularly fixed bed reactors. However the process is also practicable with other extraction reactors. If fixed bed reactors are used, the solubilized tannin liquor may be introduced into the flow of extraction liquid between any two of the fixed bed extraction reactors. However best results are obtained when the solubilized tannin liquor is introduced into the flow of extraction liquid immediately prior to the fixed bed reactor which contains the fresh tea leaves.

Brief Summary Text (48):

If the solubilized tannin liquid is added to the tea extract after separation of the insoluble tannins, the mixture should be subjected to further separation techniques to remove any insoluble tannins which may remain. The separation techniques described above may be used.

Brief Summary Text (49):

The tea extract obtained after removal of the insoluble tannins is processed as desired to provide a liquid tea concentrate or a soluble tea powder. The liquid tea concentrate or soluble powder may then be packaged and stored as desired. The extracts, in powder or liquid form, may then be used to produce hot or cold tea beverages as is conventional. However, the tea extract is particularly suitable for use in iced tea type beverages.

Brief Summary Text (50):

An advantage of the process is that there is no build up of residual insoluble tannins in the system. After several cycles required to reach steady state conditions, it is found that the amounts of insoluble tannins removed from the tea extract is substantially constant.

Detailed Description Text (4):

The tea extract is transferred to a steam stripper where the volatile components (the aromatics) are removed in a conventional manner. The stripped extract is then concentrated and then cooled to 7. degree. C. The cooled extract is centrifuged to give insoluble tannins and a clarified tea extract containing about 6% by weight of soluble tea solids.

Detailed Description Text (5):

About 3.5 kg of the insoluble tannins are added to about 170 kg of water to provide a tannin liquor. The acid concentration is determined by titration and the pH is taken. The tannin liquor is transferred to a column reactor of 0.2 m diameter and 5.5 m length and recirculated in the column reactor along with about 1 kg of green tea leaves. The temperature throughout is 103. degree. C. and the pressure is 1.5 MPa. About 18 m.sup.3 of oxygen is introduced into the column reactor during this time. After about 90 minutes, the solubilized tannin liquor is separated from the green tea leaves by filtration.

Detailed Description Text (6):

The solubilized tannin liquor is then cycled through an ultrafiltration membrane, rated at 1000 molecular weight, until about 118 kg of permeate is removed. The retentate is collected and its acid concentration is determined by titration and its pH is taken. The pH value of the retentate is about the same as that of the tannin liquor but the acid concentration by titration is about 27% lower.

Detailed Description Text (8):

The clarified tea extract at steady state is diluted to a concentration of about 0.25% of soluble tea solids and the NTU is measured. An NTU of about 25 to about 40 is obtained indicating very good solubilization of the insoluble tannins. The color of the diluted tea extract is determined to be about 50 to 55. The diluted tea beverage is tasted and found to have a good flavor.

Detailed Description Text (10):

The process of example 1 is repeated except that the permeate from the ultrafiltration step is subjected to nanofiltration (rated at 2 to 500 molecular weight). The retentate is collected and combined with the retentate from the ultrafiltration step. The pH value of the combined retentate is about the same as that of the tannin liquor but the acid concentration by titration is about 15% to about 22% higher than that of example 1 when only ultrafiltration is used. Also, about 97% of all insoluble solids originally in the tannin liquor are present in the combined retentate.

Detailed Description Text (13):

The process of example 2 is repeated except that no green tea leaves are recycled in the column reactor with the tannin liquor. The clarified tea extract, when diluted to a concentration of about 0.25% of soluble tea solids, has a NTU and color about the same as the diluted tea extract of example 2. The diluted tea beverage is tasted and found to have a good flavor.

Detailed Description Text (15):

A solubilized tannin liquor is prepared as described in example 1. However, instead of subjecting the solubilized tannin liquor to ultrafiltration, the solubilized tannin liquor is introduced into the top of a sieve tray column at a rate of about 11.4 kg/minute. About 1.3 kg/minute of steam introduced into the bottom of the column and caused to flow counter-current to the solubilized tannin liquor to strip off acids. The pH of the solubilized tannin liquor prior to stripping is about 3.6 while the pH of the stripped liquor is about 3.8. However the acid concentration by titration of the stripped liquor is not appreciably reduced.

Detailed Description Text (17):

The clarified tea extract at steady state is diluted to a concentration of about 0.25% of soluble tea solids and the NTU is measured. An NTU of less than about 40 is obtained indicating very good solubilization of the insoluble tannins. The color of the diluted tea extract is determined to be about 50 to 55. The diluted tea beverage is tasted and found to have a good flavor.

Detailed Description Text (19):

The process of example 4 is repeated except that, instead of subjecting the solubilized tannin liquor to steam stripping, the solubilized tannin liquor is

contacted with washed, spent tea leaves for about 15 to 30 minutes. The weight ratio of tannin solids to spent dry tea leaves is about 1:1. Water at about 60.degree. C. is added to the mixture. The solubilized tannin liquor is separated from the spent tea leaves by decantation. The decanted liquor is pumped into the flow of extraction liquid through the series of fixed bed reactors; between the second and first reactors. The process is repeated until steady state is achieved.

Detailed Description Text (20):

The clarified tea extract at steady state is diluted to a concentration of about 0.25% of soluble tea solids and the NTU is measured. An NTU of less than about 40 is obtained indicating very good solubilization of the insoluble tannins. The color of the diluted tea extract is determined to be about 50 to 55. The diluted tea beverage is tasted and found to have a good flavor.

Detailed Description Text (22):

Insoluble tannins and clarified tea extract are produced as described in example 1. Water is added to the insoluble tannins to provide a solids concentration of about 2% and the resulting tannin liquor is fed into the bottom of a column reactor at a flow rate of about 4.5 kg per minute. The column reactor has a diameter of about 0.2 m and a length of about 5.5 m. Oxygen is fed into the column reactor, at a flow rate of about 0.029 m.³/minute, through sintered metal rods located at the bottom of the column reactor and at about 1.5 m up. The temperature is about 103.degree. C. and the pressure is about 1.5 MPa. The tannin liquor has a residence time of about 30 minutes in the column reactor prior to leaving through an outlet adjacent the top.

Detailed Description Text (23):

A portion of the solubilized tannin liquor is cycled through an ultrafiltration membrane, rated at 1000 molecular weight. The retentate is collected and combined with the remaining solubilized tannin liquor and the mixture pumped into the flow of extraction liquid through the series of fixed bed reactors; between the second and first reactors. The process is repeated until steady state is achieved.

Detailed Description Text (24):

The clarified tea extract at steady state is diluted to a concentration of about 0.25% of soluble tea solids and the NTU is measured. An NTU of less than about 40 is obtained indicating very good solubilization of the insoluble tannins. The color of the diluted tea extract is determined to be about 45 to 49. The diluted tea beverage is tasted and found to have a good flavor.

Detailed Description Text (26):

Solubilized tannin liquor is prepared as described in Example 1. However, instead of subjecting the solubilized tannin liquor to ultrafiltration, the solubilized tannin liquor is added to the clarified tea extract. The mixture is subjected to secondary centrifugation to remove insoluble tannins which form in the mixture to provide a clarified tea extract and insoluble tannins. These insoluble tannins are added to insoluble tannins from fresh tea extract and the insoluble tannin mixture is solubilized as described in example 1.

Detailed Description Text (27):

This process is repeated with steady state being established in terms of insoluble tannins being formed. The clarified tea extract obtained from the secondary centrifugation is diluted to a concentration of about 0.25% by weight of soluble tea solids. The diluted tea beverage is clear and has good color.

CLAIMS:

1. A process for producing a tea extract which contains solubilized tannins, the process comprising:

- i) extracting tea solids from tea leaves using an extraction liquid to provide a tea extract containing soluble tea solids and insoluble tannins;
- ii) separating the insoluble tannins from the tea extract to obtain a clarified tea extract;
- iii) oxidizing and solubilizing the tannins under raised temperature conditions to provide a solubilized tannin liquor; and
- iv) adding the solubilized tannin liquor to the extraction liquid during extraction of tea solids from tea leaves in step i); and
- v) collecting the clarified tea extract of step ii) to obtain a tea extract which contains solubilized tea tannins.

2. A process according to claim 1 in which the tea solids are extracted from the tea leaves in a series of inter-connected fixed-bed reactors; the solubilized tannin liquor of step iv) being added to the extraction liquid between one or more adjacent pairs of fixed-bed reactors of the series.

3. A process according to claim 2 in which one of the fixed-bed reactors contains fresh tea leaves and the solubilized tannin liquor is added to the extraction liquid immediately prior to the fixed-bed reactor containing the fresh tea leaves.

4. A process according to claim 1 in which the insoluble tannins are oxidized using a gaseous oxidizing agent.

6. A process according to claim 1 in which the temperature at which the insoluble tannins are oxidized is about 80.degree. C. to about 130.degree. C.

7. A process according to claim 6 in which the insoluble tannins are oxidized at a pressure of about 1.5 MPa to about 2.0 MPa.

8. A process according to claim 1 further comprising the step of removing acids from at least a portion of the solubilized tannin liquor of step iv) prior to adding the solubilized tannin liquor to the extraction liquid.

9. A process according to claim 8 in which the acids are removed by ultrafiltration of the solubilized tannin liquor, by steam stripping of the solubilized tannin liquor, or by contacting the solubilized tannin liquor with spent tea leaves, or combinations thereof.

10. A process according to claim 1 further comprising separating solubilized tannin liquor of step iv) into a first and a second stream, removing acids from the solubilized tannin liquor in the first stream, and combining the first stream with the second stream prior to adding the solubilized tannin liquor to the extraction liquid.

11. A process according to claim 10 in which the acids are removed by ultrafiltration of the solubilized tannin liquor, by steam stripping of the solubilized tannin liquor, or by contacting the solubilized tannin liquor with spent tea leaves, or combinations thereof.

12. A process for producing a tea extract which contains solubilized tannins, the process comprising:

- i) extracting tea solids from tea leaves using an extraction liquid to provide a tea extract containing soluble tea solids and insoluble tannins;
- ii) separating the insoluble tannins from the tea extract to obtain a clarified tea

extract;

iii) oxidizing and solubilizing the tannins under raised temperature conditions to provide a solubilized tannin liquor;

iv) removing acids from at least a portion of the solubilized tannin liquor; and

v) adding the solubilized tannin liquor to the extraction liquid during extraction of tea solids from tea leaves in step i); and

vi) collecting the clarified tea extract of step ii) to obtain a tea extract which contains solubilized tea tannins.

13. A process according to claim 12 in which the tea solids are extracted from the tea leaves in a series of inter-connected fixed-bed reactors; the solubilized tannin liquor of step v) being added to the extraction liquid between one or more adjacent pairs of fixed-bed reactors of the series.

14. A process according to claim 13 in which one of the fixed-bed reactors contains fresh tea leaves and the solubilized tannin liquor is added to the extraction liquid immediately prior to the fixed-bed reactor containing the fresh tea leaves.

15. A process for producing a tea extract which contains solubilized tannins, the process comprising:

i) extracting tea solids from tea leaves in a series of inter-connected fixed-bed reactors using an extraction liquid to provide a tea extract containing soluble tea solids and insoluble tannins;

ii) separating the insoluble tannins from the tea extract;

iii) oxidizing and solubilizing the tannins under raised temperature conditions to provide a solubilized tannin liquor; and

iv) adding the solubilized tannin liquor to the extraction liquid between one or more adjacent pairs of fixed-bed reactors of the series during extraction of tea solids from tea leaves in step i); and

v) collecting the tea extract of step ii) which contains solubilized tea tannins.

16. A process according to claim 15 further comprising the step of removing acids from at least a portion of the solubilized tannin liquor prior to adding the solubilized tannin liquor to the extraction liquid.

17. A process according to claim 16 in which the acids are removed by ultrafiltration of the solubilized tannin liquor, by steam stripping of the solubilized tannin liquor, or by contacting the solubilized tannin liquor with spent tea leaves, or combinations thereof.

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L6 Entry 1 of 4

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TITLE: Method for obtaining grape tannin, resulting tannin and uses**Abstract Text (1):**

The invention concerns a method for obtaining grape pomace and/or seed tannin, comprising steps which consist in: (a) from fresh black or white grapes pomace and/or seed, carrying out a solid-liquid extraction of raw tannin fraction in an aqueous solvent; (b) eliminating the first solvent from the resulting extract to obtain a concentrate of the raw tannin fraction; and (c) purifying the raw tannin fraction to obtain said tannin: The method is characterised in that in step (a) sulphite water (H₂SO₃) is used as solvent, and in step (c) the raw tannin fraction is purified by selectively adsorbing the tannin polyphenol compounds on resin and by subsequent filtering. The invention also concerns the resulting tannin and its uses in particular as endogenous tannin in wine.

Brief Summary Text (1):

The present invention relates to the production, from fresh black or white grapes, of grape tannin from the marc or seed, containing a high content of polyphenolic compounds, the tannin thus obtained and the uses thereof especially in oenology.

Brief Summary Text (2):

Tannins are substances of plant origin which consist of polyphenolic compounds and which are divided into two main groups, catechuic tannins also called condensed or procyanidin tannins, to which the grape tannins belong, and the hydrolysable tannins predominantly comprising gallotannins and ellagitannins. Grape tannins are naturally present in grape skins and seeds.

Brief Summary Text (3):

These two groups are distinguishable by the nature of the polyphenolic compounds which they contain. The catechuic tannins resemble catechuic derivatives and procyanidolic oligomers and polymers consisting of 3-flavanol and 3,4-flavanediol units. More particularly, grape seed and skin tannins consist of catechin, epicatechin and epicatechin-3-O-gallate, the skin tannin containing, in addition, epigallocatechin which is absent from seed tannin. The polymers of skin tannin are longer (chains of up to 80 units) than the polymers of seed tannin (chains not exceeding 30 to 35 units). Finally, there are grafted on seed tannin molecules of gallic acid which is only present in very small quantities in skin tannin.

Brief Summary Text (4):

Gallotannins of the hydrolysable tannin group consist of polymers of glucose and of gallic acid and the ellagitannins of the same group consist of a polymer of glucose and of ellagic, gallic and/or hexahydroxydiphenic acids.

Brief Summary Text (5):

In oenology, tannins are used for the clarification of wines because they exhibit a strong affinity to bind to proteins. They are also used for improving the organoleptic qualities and the taste characters of wines.

Brief Summary Text (6):

Tannins extracted from chestnut tree, oak tree and nut galls of various trees,

which are hydrolysable tannins, are mainly used.

Brief Summary Text (7):

The application of tannins is not limited to oenology, but it extends to many other sectors such as the tanning, agri-food, pharmaceutical, cosmetic, ceramic and textile sectors and the like.

Brief Summary Text (8):

Grape tannins are not used on an industrial scale in the manufacture of wines because of the low content of phenolic compounds in the extracts obtained. Indeed, the methods currently used for preparing grape tannins cause substantial degradation of the said compounds.

Brief Summary Text (9):

Despite the small proportion of polyphenolic compounds which they contain, grape tannins, and more particularly grape seed tannins, are used in the pharmaceutical sector as a medicament in particular for treating venous insufficiency-related disorders. The active ingredient is the fraction of procyanidolic oligomers contained in the tannin. However, because of the high degradability of these tannins, the purity, in relation to the said oligomers, of the medicaments currently available does not exceed 20%.

Brief Summary Text (10):

The method of production which is conventionally followed for obtaining tannins, grape tannins for example, consists in: (a) carrying out, starting with fresh black and/or white grape marc and/or seed, a solid-liquid extraction of a crude tannin fraction in an aqueous solvent, (b) removing the aqueous solvent from the resulting extract in order to obtain a concentrate of the crude tannin fraction, and (c) purifying the crude tannin fraction in order to obtain the said tannin, by a liquid-liquid extraction, evaporation of the solvent in which the tannin is solubilized and then filtration on activated charcoal.

Brief Summary Text (11):

According to the present invention, there is provided a method for producing a tannin having a high content of polyphenolic compounds, the said method incorporating defined stages such that they make it possible to preserve the integrity of the said compounds.

Brief Summary Text (12):

The method of the invention is characterized in that, in combination, according to stage (a) sulphited water (H_2SO_2) is used as solvent, and according to stage (c) the crude tannin fraction is purified by selective adsorption of the polyphenolic compounds of the tannin on resin and subsequent filtration.

Brief Summary Text (15):

Grape marc tannin is therefore understood to mean the tannin obtained by treating the grape marc as defined above. However, given that the substances constituting the marc tannin are in fact obtained mainly from the grape skin, this expression ought to more precisely be understood to mean a grape skin tannin. In oenology, the marc is in fact a portion of the grapes harvested for winemaking, of white wine only, which is recovered after pressing the grape juice and then separating out the seeds. Accordingly, it generically designates the skin. Thus, according to the method of the invention, when the starting material is fresh grape marc, it will be understood that this may be the skin of fresh grape alone.

Brief Summary Text (17):

The nature of the total phenolic compounds varies according to the type of tannin, as specified above. Their content is however always determined as equivalent gallic acid, according to the tannic acid technique of the international oenological codex.

Brief Summary Text (18):

Using the method of the invention, a tannin is obtained which comprises in particular gambiriines which are dimers. The tannin from the skin and the stalk according to the method described above comprises, in addition, resveratrol. The tannin from the skin also comprises various flavonols such as quercetin and kaempferol.

Brief Summary Text (19):

Advantageously, the method is defined by the following additional characteristics, taken in combination or otherwise: stage (a) is carried out at a temperature at most equal to 25.degree. C., and preferably of between 15 and 25.degree. C., stage (b) is carried out by evaporation under vacuum at a temperature at most equal to 75.degree. C., after evaporation according to stage (b), the concentrate of the crude tannin fraction is immediately cooled to a temperature at most equal to 30.degree. C., the method comprises a stage (b'), between stages (b) and (c), according to which a fermentation of the concentrate of the crude tannin fraction is carried out; for the purposes of stage (b'), yeasts in suspension in a liquid medium are inoculated into the concentrate of the crude tannin fraction; the fermentation is allowed to proceed; the alcohol formed is removed followed by the particles in suspension in order to obtain a concentrate of the fermented crude tannin fraction.

Brief Summary Text (20):

The objective of the fermentation is the conversion of sugars to alcohol as well as the beneficial conversion of the tannins. This conversion makes the tannins conform to the organoleptic requirements of wines, because they undergo the same process of conversion as the intrinsic tannins of the wine. according to stage (c), the crude tannin fraction is adsorbed on a resin, of the preferably microcrosslinked styrene divinylbenzene (DVB) type, according to stage (c), the crude tannin fraction treated on resin is filtered by diafiltration, in particular selective diafiltration; the latter is advantageously carried out at a temperature at most equal to 25.degree. C.

Brief Summary Text (21):

Other subjects of the invention are: the black and/or white grape marc tannin which can be obtained by the method of the invention, comprising a content of total polyphenolic compounds of at least about 300 mg equivalent gallic acid per g of dry matter, and the black and/or white grape seed tannin which can be obtained by the method of the invention, comprising a content of total polyphenolic compounds of at least about 500 mg equivalent gallic acid per g of dry matter.

Brief Summary Text (22):

The invention relates, in addition, to the use of a white grape marc tannin as defined above, as endogenous tannin in wine. It also relates to the use of a grape tannin of the invention for producing an extract rich in procyanidolic oligomers.

Detailed Description Text (21):

A rise would be damaging to the quality of the tannin obtained, and would bring about the extraction of other undesirable compounds.

Detailed Description Text (29):

The concentrate of the crude tannin fraction obtained is immediately cooled to between 26 and 28.degree. C., for the next fermentation stage (b').

Detailed Description Text (34):

As soon as the fermentation ends, the fermented crude tannin fraction is cooled to 15.degree. C. This cooling makes it possible to obtain sufficient clarification by settling for the removal of the alcohol formed (or dealcoholization).

Detailed Description Text (45):

5.1) Purification by Selective Adsorption of the Polyphenolic Compounds in the Tannin

Detailed Description Text (49):

The treatment of the concentrate of the crude fermented tannin fraction obtained in 4), with the materials described above, comprises two stages: a phase of selective attachment of the polyphenolic compounds by adsorption onto the resin, and therefore removal of the compounds other than the polyphenolic compounds, and then a phase of elution of the phenolic compounds adsorbed by an ethanol solution at 50.degree. GL.

Detailed Description Text (52):

A nanofiltration module equipped with organic membranes having a cut-off of 100 to 300 daltons is used.

CLAIMS:

1. A method for producing a grape marc and/or seed tannin comprising: (a) carrying out, starting with fresh black and/or white grape marc and/or seed, a solid-liquid extraction of a crude tannin fraction in sulphited water (H₂SO₃ 0.2-0.5%), with the materials described above, comprises two stages: a phase of selective attachment of the polyphenolic compounds by adsorption onto the resin, and therefore removal of the compounds other than the polyphenolic compounds, and then a phase of elution of the phenolic compounds adsorbed by an ethanol solution at 50.degree. GL.

5. The method according to claim 1, wherein, after evaporation, the concentrate of the crude tannin fraction is immediately cooled to a temperature at most equal to 30.degree. C.

6. The method according to claim 1, wherein (c) is carried out by inoculating yeasts in suspension in a liquid medium into the concentrate of the crude tannin fraction; allowing to proceed yielding alcohol and suspended particles; and removing the formed alcohol and the particles in suspension.

7. The method according to claim 1, wherein in (d), the crude tannin fraction is absorbed on the resin, which is of the styrene DVB type.

8. The method according to claim 1, wherein the subsequent filtration is a diafiltration.

9. A method for producing a grape marc and/or seed tannin comprising: (a) carrying out, starting with fresh black and/or white grape marc and/or seed, a solid-liquid extraction of a crude tannin fraction in water sulphited with 1 to 1.5 grams of sulfur dioxide per liter; (b) removing at least part of the aqueous solvent from the resulting extract in order to obtain a concentrate of the crude tannin fraction; (c) obtaining a concentrate of the fermented crude tannin fraction by inoculating yeasts into the concentrate of the crude tannin fraction; (d) purifying the crude tannin fraction in order to obtain the tannin by selective adsorption of the polyphenolic compounds of the concentrate onto a resin, elution of the polyphenolic compounds from the resin and subsequent filtration.

[Previous Doc](#)[Next Doc](#)[Go to Doc#](#)

AN 1977:428593 CAPLUS

DN 87:28593

TI Purification of industrial waste waters

IN Wegmueller, Hans; Haase, Jaroslav

PA Ciba-Geigy A.-G., Switz.

SO Patentschrift (Switz.), 6 pp. Addn. to Swiss 566,942.

CODEN: SWXXAS

DT Patent

LA German

FAN.CNT 3

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	CH 584657	A	19770215	CH 1973-5225	19730412 <--
	ES 414563	A1	19760516	ES 1973-414563	19730509 <--
PRAI	CH 1972-7012		19720510		
	CH 1973-5225		19730412		
PI	CH 584657 19770215				
	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	CH 584657	A	19770215	CH 1973-5225	19730412 <--
	ES 414563	A1	19760516	ES 1973-414563	19730509 <--

DT Patent

AB Dyestuffs, anionic detergents, optical brighteners, and tannins

having COOH or SO₃H groups are removed from industrial waste water by filtering through cellulose pulp impregnated by basic polymers (amino resins, and polyamides) and acidic polymers (polymethacrylic acid [25087-26-7] or carboxymethylcellulose [9004-32-4]). Thus, sulfite cellulose 10, water 500, and Versamid 140 [12624-35-0] 1kg are blended 3 h at 20°, mixed with 33.6 L 1% aqueous polymethacrylic acid (mole weight 80-100,000 and neutralized with NaOH to pH 6.1), and mixed with 6.67 L 10% aqueous AlCl₃ 10% (alkalized to pH 9.5). The pulp is pressed to 30 kg and used for filtering 6000 L waste water containing 30 kg acidic dyestuff at pH 4 and 95-7° resulting in a colorless filtrate.

AN 1995:498859 CAPLUS
DN 122:264083
TI Investigation of plugging colloids on microporous membrane filters
AU Meier, Peter M.; Jansen, Gary P.; Blazka, Stephan; Hegde, Ramesh
CS Millipore Corp, Bedford, 01730, USA
SO Technical Quarterly - Master Brewers Association of the Americas (1995), 32(1), 25-34
CODEN: TQMBAC; ISSN: 0542-9811
DT Journal
LA English
SO Technical Quarterly - Master Brewers Association of the Americas (1995), 32(1), 25-34
CODEN: TQMBAC; ISSN: 0542-9811
IT **Polyamides**, biological studies
RL: FFD (Food or feed use); PEP (Physical, engineering or chemical process); BIOL (Biological study); PROC (Process); USES (Uses)
(fouling colloids on microporous polyvinylidene fluoride and nylon membrane filters used in breweries)
IT **Tannins**
RL: ADV (Adverse effect, including toxicity); PEP (Physical, engineering or chemical process); BIOL (Biological study); PROC (Process)
(tannins and other fouling colloids on microporous polyvinylidene fluoride and nylon membrane filters used in breweries)

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> s ((polyether?(w)sulfon?) or polyamid?)(1)membran?(1)?filtra?
  79015 POLYETHER?
  264344 SULFON?
  152674 POLYAMID?
  717202 MEMBRAN?
  390048 ?FILTRA?
L12      1025 ((POLYETHER?(W)SULFON?) OR POLYAMID?)(L)MEMBRAN?(L)?FILTRA?

=> s l12(1)tannin?
  48833 TANNIN?
L13      4 L12(L)TANNIN?

=> d bib hit 1-4

L13  ANSWER 1 OF 4  CAPLUS  COPYRIGHT 2004 ACS on STN
AN  2004:294283  CAPLUS
DN  141:90804
TI  Recovery and recycle of tannins in the leather industry by nanofiltration
membranes
AU  Molinari, R.; Buonomenna, M. G.; Cassano, A.; Drioli, E.
CS  Department of Chemical and Materials Engineering, Institute of Membrane
Technology, ITM-CNR (former IRMERC-CNR), University of Calabria, Rende,
I-87030, Italy
SO  Journal of Chemical Technology and Biotechnology (2004), 79(4), 361-368
CODEN: JCTBED; ISSN: 0268-2575
PB  John Wiley & Sons Ltd.
DT  Journal
LA  English
RE.CNT 27  THERE ARE 27 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT
AB  The aim of this work was the study of the application of membrane
concentration to exhausted tanning baths from vegetable tannage
operations in order to increase the tannin/non-tannin
(T/NT) ratio and obtain recyclable material. For this purpose four
samples of tanning baths at different T/NT ratios (from 0.7 to
1.4) were processed using six different types of membranes which
ranged from reverse osmosis (RO) to nanofiltration (NF). The
membrane module Fluid Systems TFC S 2540 gave the best results in
terms of permeate flux and also in terms of increased T/NT ratio in the
retentate (from 1.4 to 1.7). In order to compare the permeate flux reduction
with time (Jt) for the different modules, the osmotic pressure differences
(Δπ) between permeate and retentate were estimated by elec. conductivity
measures. The fouling phenomena for the different membranes in
the processing of each sample were evaluated by comparing the pressures
required to obtain the same VRF (volume reduction factor), NPF (normalized
permeate flux) and membrane performances with tap water before
and after tannin concentration. The retention of tannins,
which are polyphenols capable of significant hydrogen bonding, was found
to be governed by the chemical of the interactions between their complexes
and the polyamide membrane material.
IT  Polyamides, uses
RL: TEM (Technical or engineered material use); USES (Uses)
  (membrane; recovery and recycle of tannins in the
  leather industry by nanofiltration membranes)
L13  ANSWER 2 OF 4  CAPLUS  COPYRIGHT 2004 ACS on STN
AN  2002:937641  CAPLUS
DN  137:384692
TI  Procedure for extracting refined tannins from ligneous matter
IN  Bertola, Roberto; Rizzi, Achille
PA  Nuova Rivart S.p.A., Italy
SO  Ital., 14 pp.
CODEN: ITXXBY
DT  Patent

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LA Italian

FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	IT 1304563	B1	20010319	IT 1998-RE69	19980702
	IT 98RE0069	A1	20000103		
PRAI	IT 1998-RE69		19980702		

IT Polyamides, uses

RL: NUU (Other use, unclassified); USES (Uses)
(as twisted spiral semipermeable membranes in
microfiltration in; extraction and purification of tannins from
ligneous matter via lixiviation, clarification and filtration
stages)

L13 ANSWER 3 OF 4 CAPLUS COPYRIGHT 2004 ACS on STN

AN 1999:745777 CAPLUS

DN 131:341326

TI Treatment of an industrial effluent by reverse osmosis

AU Padilla, Antonio Perez; Tavani, Eduardo L.

CS Instituto de Investigaciones en Tecnologia Quimica (INTEQUI), Universidad
Nacional de San Luis, CONICET, San Luis, 5700, Argent.

SO Desalination (1999), 126(1-3), 219-226

CODEN: DSLNAH; ISSN: 0011-9164

PB Elsevier Science B.V.

DT Journal

LA English

RE.CNT 23 THERE ARE 23 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

AB The treatment of tanning wastewater was studied by means of reverse osmosis and ultrafiltration. Tests were carried out on laboratory scale using membranes of polyamide (reverse osmosis) and of polysulfone (ultrafiltration). The evaluation of the system was performed by chemical anal., pH measurements and visible spectrophotometry. Effects of the protein contained in the industrial effluent, the applied pressure and the feed temperature on the permeate flux were analyzed. The polyamide membrane used allowed us to obtain permeates with a low chromium (III) content (7-10 mg/L) but with appreciable amts. of SO4= (1-3 g/l), Cl- (9-14 g/L) and Na+ (5-10 g/L). The presence of chromium (III) polymers was determined in the original effluent and in the concs. obtained by reverse osmosis. Finally, it was established that during the operation of reverse osmosis, the transport of H+(H3O+) from the concentrate to the permeate was produced.

IT Wastewater

Wastewater

(tannery; treatment of tanning wastewater using
polyamide membrane reverse osmosis and polysulfone
membrane ultrafiltration)

IT Tanning (curing)

Tanning (curing)

(wastewater; treatment of tanning wastewater using
polyamide membrane reverse osmosis and polysulfone
membrane ultrafiltration)

L13 ANSWER 4 OF 4 CAPLUS COPYRIGHT 2004 ACS on STN

AN 1999:297339 CAPLUS

DN 130:313411

TI Percolation-nanofiltration process and plant to extract and concentrate tannins from wood and other natural products

IN Mustacchi, Carlo; Danesi, Paolo; Festuccia, Andrea

PA Proras S.R.L., Italy; Arcangeli, Adriana; Matturro, Giacomo

SO PCT Int. Appl., 20 pp.

CODEN: PIXXD2

DT Patent

LA English

FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	WO 9921634	A1	19990506	WO 1998-EP6804	19981027
	W: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM				
	RW: GH, GM, KE, LS, MW, SD, SZ, UG, ZW, AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG				
	CA 2307628	AA	19990506	CA 1998-2307628	19981027
	AU 9916644	A1	19990517	AU 1999-16644	19981027
	AU 749605	B2	20020627		
	EP 1027120	A1	20000816	EP 1998-961103	19981027
	EP 1027120	B1	20021218		
	R: AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, NL, SE, MC, PT, IE, SI, FI, RO				
	TR 200001163	T2	20000821	TR 2000-200001163	19981027
	BR 9813342	A	20000822	BR 1998-13342	19981027
	AT 229837	E	20030115	AT 1998-961103	19981027
	ES 2189281	T3	20030701	ES 1998-961103	19981027
PRAI	IT 1997-RM653	A	19971028		
	WO 1998-EP6804	W	19981027		

RE.CNT 18 THERE ARE 18 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

AB Solid products are subjected to extraction by percolation with water and/or steam and the thus obtained tannin solution is subjected to **nanofiltration** with spiral-wound **membranes**. The tannins have higher activity because they are not degraded by heavy heat treatments, and water and fuel usage are much lower than in traditional separation methods. Thus, 350 kg chopped chestnut wood was loaded to each of 3 extractors connected in parallel and extracted 4 h at 110°, 0.8 bar pressure, and water-wood ratio 1:1, giving extraction yield 95% and tannin concentration 8%. The solution from the extraction unit was clarified and nanofiltered at 50° and 4 MPa using a 50-mil Desal 5DK polyamide spiral-wound **membrane**, giving tannin concentration in permeate 58.7%, permeate flux 25 L/m².h, and rejection 99.8%.

IT **Membrane filters**
(**nanofiltration**, spiral-wound **polyamide** or **polyethersulfone**; **percolation-nanofiltration** process and plant to extract and concentrate tannins from wood and other natural products)

IT **Polyamides, uses**
RL: TEM (Technical or engineered material use); USES (Uses)
(spiral-wound **nanofiltration** **membranes**;
percolation-nanofiltration process and plant to extract and concentrate tannins from wood and other natural products)

=> s l12 and tannin?
48833 TANNIN?
L14 8 L12 AND TANNIN?

=> s l14 not l13
L15 4 L14 NOT L13

=> d bib hit 1-4

L15 ANSWER 1 OF 4 CAPLUS COPYRIGHT 2004 ACS on STN
AN 2004:135465 CAPLUS
DN 140:411854
TI Nanofiltration of colored surface water: Quebec's experience
AU Kouadio, P.; Tetrault, M.
CS H2O Innovation (2000) inc., Quebec, QC, G1K 8M4, Can.
SO Water Science & Technology: Water Supply (2003), 3(5-6), 15-22
CODEN: WSTWBM; ISSN: 1606-9749
PB IWA Publishing
DT Journal
LA English
RE.CNT 3 THERE ARE 3 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT
IT Humus
Organic compounds, processes
Sulfates, processes
Tannins
RL: OCU (Occurrence, unclassified); PEP (Physical, engineering or chemical process); PYP (Physical process); REM (Removal or disposal); OCCU (Occurrence); PROC (Process)
(efficiency of nanofiltration color removal from lake water in Lac Bouchette, Latulipe-et-Gaboury, and Charlesbourg, Quebec, Canada)
IT Polyamides, uses
RL: DEV (Device component use); TEM (Technical or engineered material use); USES (Uses)
(nanofiltration thin-film composite membrane;
efficiency of nanofiltration color removal from lake water in Lac Bouchette, Latulipe-et-Gaboury, and Charlesbourg, Quebec, Canada)

L15 ANSWER 2 OF 4 CAPLUS COPYRIGHT 2004 ACS on STN
AN 2002:208033 CAPLUS
DN 137:19597
TI Fouling of organic microfiltration membranes by wine constituents: importance, relative impact of wine polysaccharides and polyphenols and incidence of membrane properties
AU Vernhet, Aude; Moutounet, Michel
CS UMR Sciences Pour l'Enologie, Centre de Recherches ENSAM/INRA, Montpellier, 34060, Fr.
SO Journal of Membrane Science (2002), 201(1-2), 103-122
CODEN: JMESDO; ISSN: 0376-7388
PB Elsevier Science B.V.
DT Journal
LA English

RE.CNT 31 THERE ARE 31 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

IT Polysaccharides, biological studies
Tannins
RL: BSU (Biological study, unclassified); OCU (Occurrence, unclassified); BIOL (Biological study); OCCU (Occurrence)
(fouling of organic microfiltration membranes by wine constituents)
IT 75-11-6, Diiodomethane 75-12-7, Formamide, biological studies
112-40-3, Dodecane 7732-18-5, Water, biological studies 9003-39-8,
Polyvinylpyrrolidone 25667-42-9, Polyether sulfone
RL: BUU (Biological use, unclassified); BIOL (Biological study); USES (Uses)

(fouling of organic microfiltration membranes by wine constituents)

L15 ANSWER 3 OF 4 CAPLUS COPYRIGHT 2004 ACS on STN
AN 2001:445350 CAPLUS
DN 135:157278
TI Predictive membrane transport model for nanofiltration processes in water treatment
AU Tu, Shih-Chieh; Ravindran, Varadarajan; Den, Walter; Pirbazari, Massoud
CS Dept. of Civil and Environmental Engineering, University of Southern California, Los Angeles, CA, 90089, USA
SO AIChE Journal (2001), 47(6), 1346-1362
CODEN: AICEAC; ISSN: 0001-1541
PB American Institute of Chemical Engineers
DT Journal
LA English
RE.CNT 51 THERE ARE 51 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT
AB A membrane transport model was developed for prediction and simulation of membrane filtration (nanofiltration) dynamics with reference to permeate flux. It incorporates important phenomenol. aspects of membrane transport, such as concentration polarization and gel layer formation, and illustrates the concentration of solutes as foulants in the mass-transfer boundary layer on the membrane surface. Membrane filtration tests using tannic acid as a model organic compound were designed for investigating permeate fluxes, as well as solute concentration profiles for permeates and concs. Membrane performance expts. were conducted under various operation conditions by varying several parameters including solute concns., transmembrane pressures, and reject flow rates. The tests showed that the NF 45 membrane composed of polypiperazine amide was more susceptible to organic fouling by tannic acid than the NF 70 membrane made of cross-linked aromatic polyamide. These observations were supported by surface-potential measurements that demonstrated higher neg. surface charges and greater hydrophilicity for the NF 70 membrane in the presence of tannic acid. The predictive capability of the membrane transport model was evaluated using the results from membrane filtration tests. Model sensitivity studies were conducted to obtain information on effects of various input parameters pertaining to operating conditions and fluid-dynamic regimes.
IT Polyamides, uses
RL: DEV (Device component use); USES (Uses)
(aromatic, cross-linked; predictive membrane transport model for nanofiltration processes in water treatment)
IT Organic compounds, processes
Tannins
RL: REM (Removal or disposal); PROC (Process)
(predictive membrane transport model for nanofiltration processes in water treatment)

L15 ANSWER 4 OF 4 CAPLUS COPYRIGHT 2004 ACS on STN
AN 1985:150371 CAPLUS
DN 102:150371
TI Crosslinked porous membranes
IN Ford, Douglas Lyons
PA Memtec Ltd., Australia
SO PCT Int. Appl., 29 pp.
CODEN: PIXXD2
DT Patent
LA English
FAN.CNT 1
PATENT NO. KIND DATE APPLICATION NO. DATE
----- ----- ----- ----- -----

PI	WO 8403054	A1	19840816	WO 1984-AU15	19840126
	W: AU, JP, US				
	RW: AT, BE, CH, DE, FR, GB, NL, SE				
	AU 8424325	A1	19840830	AU 1984-24325	19840126
	AU 571194	B2	19880414		
	JP 60500406	T2	19850328	JP 1984-500664	19840126
	JP 02017216	B4	19900419		
	EP 135514	A1	19850403	EP 1984-900597	19840126
	EP 135514	B1	19901107		
	R: AT, BE, CH, DE, FR, GB, LI, NL, SE				
	AT 58068	E	19901115	AT 1984-900597	19840126
	US 4661526	A	19870428	US 1984-662293	19841001
	CA 1288561	A1	19910910	CA 1986-507896	19860429
	JP 03021334	A2	19910130	JP 1989-249407	19890927
	JP 04071571	B4	19921116		
PRAI	AU 1983-7861		19830202		
	EP 1984-900597		19840126		
	WO 1984-AU15		19840126		

AB A polymeric porous **membrane** is manufactured from a thermoplastic **polyamide** or **polyamide-polyimide** having both relatively noncryst. and relatively crystalline portions joined together by relatively noncryst. portions and having at least some of the crystalline portions linked together by an aldehyde, preferably a bisaldehyde. Thus, 90 g nylon 6 filaments were dissolved in 15 min at 22° in a solvent consisting of 15 mL anhydrous EtOH and 225 mL 6.67 N HCl, matured 24 h at 22°, spread as a film 120-μ-thick on a glass plate, placed in a water bath to precipitate the dissolved portions of the **polyamide** in 3 min, and treated with 5% glutaraldehyde (I) at pH 3-6 at 60° overnight. Approx. 50-80% of I had reacted and 10-25% I had one aldehyde group free for further reactions. The **membrane** had water permeability 339 L/m²/h and rejected 81% protein in a standard edible gelatin. The **membrane** was modified by treatment with resorcinol, gelatin, hydroxyethyl cellulose and the **filtration** and ion exchange properties determined

IT

Tannins

RL: USES (Uses)

(glutaraldehyde-crosslinked nylon 6 membranes modified by, for ultrafilters and ion exchangers)

L3 ANSWER 1 OF 1 CAPLUS COPYRIGHT 2004 ACS on STN
AN 2002:798365 CAPLUS
DN 137:357424
TI Determination of naphthalene **sulfonates** in tannery wastewater and their behavior in a **membrane** bioreactor
AU Stuber, Markus; Reemtsma, Thorsten; Jekel, Martin
CS Institut fur Technischen Umweltschutz, Fachgebiet Wasserreinhaltung, Technische Universitaet Berlin, Berlin, D-10623, Germany
SO Vom Wasser (2002), 98, 133-144
CODEN: VJWWAU; ISSN: 0083-6915
PB Wiley-VCH Verlag GmbH & Co. KGaA
DT Journal
LA German
AB We investigated the removal of naphthalene **sulfonates** in a pressurized bioreactor with subsequent ultrafiltration treating tannery wastewater. The naphthalene **sulfonates** were analyzed directly from the complex wastewater matrixes of the influents and effluents by liquid chromatog.-electrospray ionization-tandem mass spectrometry (LC-ESI-MS/MS). The median influent concns. of naphthalene-1-**sulfonate** and naphthalene-2-**sulfonate** were 160 and 1450 μ g/L resp., the median effluent concns. in both cases were 1 μ g/L. The median concns. of the different isomers of naphthalene disulfonates ranged 20-95 μ g/L for the influents and 0.5-70 μ g/L for the effluents. With the determined concns. and the wastewater vols. over the period of investigation we calculated the elimination rates of the analytes. Naphthalene monosulfonates are almost completely removed. On the contrary the isomers of the naphthalene disulfonates show a different degradation behavior despite of their very similar structures. The median elimination rates range from 9% for naphthalene-1,5-disulfonate to 91% for naphthalene-2,6-disulfonate. Furthermore we compared our data with literature data on the elimination efficiency of the conventional activated sludge treatment. We obtained no indication for an improved degradation of these polar organic pollutants in wastewater treatment plants equipped with a **membrane** bioreactor compared to literature data on their removal in conventional activated sludge wastewater treatment plants.

RE.CNT 20 THERE ARE 20 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

TI Determination of naphthalene **sulfonates** in tannery wastewater and their behavior in a **membrane** bioreactor
AB We investigated the removal of naphthalene **sulfonates** in a pressurized bioreactor with subsequent ultrafiltration treating tannery wastewater. The naphthalene **sulfonates** were analyzed directly from the complex wastewater matrixes of the influents and effluents by liquid chromatog.-electrospray ionization-tandem mass spectrometry (LC-ESI-MS/MS). The median influent concns. of naphthalene-1-**sulfonate** and naphthalene-2-**sulfonate** were 160 and 1450 μ g/L resp., the median effluent concns. in both cases were 1 μ g/L. The median concns. of the different isomers of naphthalene disulfonates ranged 20-95 μ g/L for the influents and 0.5-70 μ g/L for the effluents. With the determined concns. and the wastewater vols. over the period of investigation we calculated the elimination rates of the analytes. Naphthalene monosulfonates are almost completely removed. On the contrary the isomers of the naphthalene disulfonates show a different degradation behavior despite of their very similar structures. The median elimination rates range from 9% for naphthalene-1,5-disulfonate to 91% for naphthalene-2,6-disulfonate. Furthermore we compared our data with literature data on the elimination efficiency of the conventional activated sludge treatment. We obtained no indication for an improved degradation of these polar organic pollutants in wastewater treatment plants equipped with a **membrane** bioreactor compared to literature data on their removal in conventional activated sludge wastewater treatment plants.

ST tannery wastewater **membrane** bioreactor naphthalenesulfonic acid
IT Wastewater treatment
 (**membrane** bioreactor; removal of naphthalenesulfonic acids
 from tannery wastewater using **membrane** bioreactor with
 subsequent ultrafiltration)
IT **Tanning** (curing)
 (removal of naphthalenesulfonic acids from tannery wastewater using
 membrane bioreactor with subsequent ultrafiltration)
IT 81-04-9, 1,5-Naphthalenedisulfonic acid 85-47-2, 1-Naphthalenesulfonic
acid 92-41-1, 2,7-Naphthalenedisulfonic acid 120-18-3,
2-Naphthalenesulfonic acid 525-37-1, 1,6-Naphthalenedisulfonic acid
581-75-9, 2,6-Naphthalenedisulfonic acid 5724-16-3, 1,7-
Naphthalenedisulfonic acid
RL: POL (Pollutant); REM (Removal or disposal); OCCU (Occurrence); PROC
(Process)
 (removal of naphthalenesulfonic acids from tannery wastewater using
 membrane bioreactor with subsequent ultrafiltration)

AN 1989:74083 CAPLUS
DN 110:74083
TI Regeneration of Spanish style green table olive brines by ultrafiltration
AU Brenes Balbuena, M.; Garcia Garcia, P.; Garrido Fernandez, A.
CS Inst. Grasa Deriv., Sevilla, 41012, Spain
SO Journal of Food Science (1988), 53(6), 1733-6
CODEN: JFDSAZ; ISSN: 0022-1147
DT Journal
LA English
AB Ultrafiltration was applied to regenerate brines from green table olive
fermns. Expts. were conducted to select optimum **membrane** pore
size and working conditions, as well as effects on characteristics of
brines and olives packed with these regenerated brines. Good decoloration
of such solns. was achieved with **polysulfonate membranes**
of 1,000 daltons pore size. The best working conditions were: 18 bars,
room temperature (25°), and without any previous filtration. Very low
reduction of NaCl and slight decrease of lactic acid were noted. No effect on
the quality of packed olives with the treated brines was detected.
AB Ultrafiltration was applied to regenerate brines from green table olive
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size and working conditions, as well as effects on characteristics of
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room temperature (25°), and without any previous filtration. Very low
reduction of NaCl and slight decrease of lactic acid were noted. No effect on
the quality of packed olives with the treated brines was detected.
ST olive brine regeneration ultrafiltration; decoloration olive brine
polysulfonate
IT **Tannins**
RL: BIOL (Biological study)
(of olive fermentation brines, **ultrafiltration** effect on)

AN 1989:483489 CAPLUS
DN 111:83489
TI Ultrafiltration of wastewaters from vegetable tanning
AU Smejkal, Pavel; Brokes, Petr; Ruprecht, Josef
CS Vyzk. Ustav Liko, Bratislava, Czech.
SO Kozarstvi (1988), 38(8), 226-8
CODEN: KOZAAT; ISSN: 0023-4338
DT Journal
LA Czech
AB Full-scale trials confirmed that vegetable tanning agents can be recovered by ultrafiltration of wastewater from hide tanning. The highest efficiency of separation of tanning agents from nontanning compds. was obtained by using cellulose acetate membranes, whereas the highest ultrafiltration capacity was shown by polysulfone membranes.
TI Ultrafiltration of wastewaters from vegetable tanning
AB Full-scale trials confirmed that vegetable tanning agents can be recovered by ultrafiltration of wastewater from hide tanning. The highest efficiency of separation of tanning agents from nontanning compds. was obtained by using cellulose acetate membranes, whereas the highest ultrafiltration capacity was shown by polysulfone membranes.
ST ultrafiltration wastewater tanning material recovery; vegetable tanning material wastewater ultrafiltration
IT Polysulfones, uses and miscellaneous
RL: USES (Uses)
(ultrafiltration membranes, for vegetable tanning wastewater treatment)
IT Wastewater treatment
(ultrafiltration, of vegetable tanning effluents, and vegetable tanning material recovery therein)
IT Tanning materials
(vegetable, recovery of, from wastewater, by ultrafiltration)
IT Tanning
(vegetable, wastewater from, ultrafiltration of, and vegetable tanning material recovery therein)
IT 9004-35-7
RL: PROC (Process)
(ultrafiltration membrane, for vegetable tanning wastewater treatment)
IT 9002-86-2
RL: PROC (Process)
(ultrafiltration membranes, for vegetable tanning wastewater treatment)
L5 ANSWER 7 OF 9 CAPLUS COPYRIGHT 2004 ACS on STN
AN 1989:74083 CAPLUS
DN 110:74083
TI Regeneration of Spanish style green table olive brines by ultrafiltration
AU Brenes Balbuena, M.; Garcia Garcia, P.; Garrido Fernandez, A.
CS Inst. Grasa Deriv., Sevilla, 41012, Spain
SO Journal of Food Science (1988), 53(6), 1733-6
CODEN: JFDSAZ; ISSN: 0022-1147
DT Journal
LA English
AB Ultrafiltration was applied to regenerate brines from green table olive fermns. Expts. were conducted to select optimum membrane pore size and working conditions, as well as effects on characteristics of brines and olives packed with these regenerated brines. Good decoloration of such solns. was achieved with polysulfonate membranes of 1,000 daltons pore size. The best working conditions were: 18 bars, room temperature (25°), and without any previous filtration. Very low reduction of NaCl and slight decrease of lactic acid were noted. No effect on

AB the quality of packed olives with the treated brines was detected.
Ultrafiltration was applied to regenerate brines from green table olive
fermns. Expts. were conducted to select optimum **membrane** pore
size and working conditions, as well as effects on characteristics of
brines and olives packed with these regenerated brines. Good decoloration
of such solns. was achieved with **polysulfonate membranes**
of 1,000 daltons pore size. The best working conditions were: 18 bars,
room temperature (25°), and without any previous filtration. Very low
reduction of NaCl and slight decrease of lactic acid were noted. No effect on
the quality of packed olives with the treated brines was detected.
ST olive brine regeneration ultrafiltration; decoloration olive brine
polysulfonate
IT **Tannins**
RL: BIOL (Biological study)
(of olive fermentation brines, **ultrafiltration** effect on)

AN 1999:745777 CAPLUS
DN 131:341326
TI Treatment of an industrial effluent by reverse osmosis
AU Padilla, Antonio Perez; Tavani, Eduardo L.
CS Instituto de Investigaciones en Tecnologia Quimica (INTEQUI), Universidad
Nacional de San Luis, CONICET, San Luis, 5700, Argent.
SO Desalination (1999), 126(1-3), 219-226
CODEN: DSLNAH; ISSN: 0011-9164
PB Elsevier Science B.V.
DT Journal
LA English
AB The treatment of tanning wastewater was studied by means of reverse osmosis and ultrafiltration. Tests were carried out on laboratory scale using membranes of polyamide (reverse osmosis) and of polysulfone (ultrafiltration). The evaluation of the system was performed by chemical anal., pH measurements and visible spectrophotometry. Effects of the protein contained in the industrial effluent, the applied pressure and the feed temperature on the permeate flux were analyzed. The polyamide membrane used allowed us to obtain permeates with a low chromium (III) content (7-10 mg/L) but with appreciable amts. of SO₄²⁻ (1-3 g/L), Cl⁻ (9-14 g/L) and Na⁺ (5-10 g/L). The presence of chromium (III) polymers was determined in the original effluent and in the concs. obtained by reverse osmosis. Finally, it was established that during the operation of reverse osmosis, the transport of H⁺(H₃O⁺) from the concentrate to the permeate was produced.
RE.CNT 23 THERE ARE 23 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT
AB The treatment of tanning wastewater was studied by means of reverse osmosis and ultrafiltration. Tests were carried out on laboratory scale using membranes of polyamide (reverse osmosis) and of polysulfone (ultrafiltration). The evaluation of the system was performed by chemical anal., pH measurements and visible spectrophotometry. Effects of the protein contained in the industrial effluent, the applied pressure and the feed temperature on the permeate flux were analyzed. The polyamide membrane used allowed us to obtain permeates with a low chromium (III) content (7-10 mg/L) but with appreciable amts. of SO₄²⁻ (1-3 g/L), Cl⁻ (9-14 g/L) and Na⁺ (5-10 g/L). The presence of chromium (III) polymers was determined in the original effluent and in the concs. obtained by reverse osmosis. Finally, it was established that during the operation of reverse osmosis, the transport of H⁺(H₃O⁺) from the concentrate to the permeate was produced.
ST tanning wastewater reverse osmosis ultrafiltration
chromium recovery
IT Wastewater
Wastewater
(tannery; treatment of tanning wastewater using polyamide
membrane reverse osmosis and polysulfone
membrane ultrafiltration)
IT Polyamides, processes
Polysulfones, processes
RL: DEV (Device component use); PEP (Physical, engineering or chemical
process); PRP (Properties); PROC (Process); USES (Uses)
(treatment of tannery effluent by reverse osmosis)
IT Tanning (curing)
Tanning (curing)
(wastewater; treatment of tanning wastewater using polyamide
membrane reverse osmosis and polysulfone
membrane ultrafiltration)

AN 2000:811842 CAPLUS
DN 133:339403
TI Ultrafiltration for color removal of tannery dyeing wastewaters
AU Alves, Ana Maria Brites; De Pinho, Maria Norberta
CS Chemical Engineering Department, Instituto Superior Tecnico, Lisbon,
1049-001, Port.
SO Desalination (2000), 130(2), 147-154
CODEN: DSLNAH; ISSN: 0011-9164
PB Elsevier Science B.V.
DT Journal
LA English
AB Investigation of ultrafiltration (UF) performance for the purpose of removing the color of 3 different effluents coming from the dyeing cycle of a tannery industry was carried out using 4 **polyethersulfone** (PES) **membranes** with mol. weight cut-offs (MWCO) of 40, 10, 5, and 3 kDa. A closed-loop recycle (CLR) and batch (B) modes of operation were used. For the first mode of operation, the evolution of permeate flux and color rejection vs. time of operation was evaluated. For the batch concentration expts., attention was focused upon the evolution of the rejection and/or concentration of color with the volume reduction factor (VRF) and on the decrease of the permeate flux as a function of VRF for all the **membranes** under study. All expts. showed the occurrence of concentration polarization and adsorptive fouling with a pronounced effect for the **membranes** with higher MWCO. Due to that, the 40 and 10 kDa **membranes** did not offer a significant regaining of permeate productivity. High-color and low-solids rejections were observed for all the expts., showing a marked dependence on the type of effluent used.
RE.CNT 6 THERE ARE 6 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT
AB Investigation of ultrafiltration (UF) performance for the purpose of removing the color of 3 different effluents coming from the dyeing cycle of a tannery industry was carried out using 4 **polyethersulfone** (PES) **membranes** with mol. weight cut-offs (MWCO) of 40, 10, 5, and 3 kDa. A closed-loop recycle (CLR) and batch (B) modes of operation were used. For the first mode of operation, the evolution of permeate flux and color rejection vs. time of operation was evaluated. For the batch concentration expts., attention was focused upon the evolution of the rejection and/or concentration of color with the volume reduction factor (VRF) and on the decrease of the permeate flux as a function of VRF for all the **membranes** under study. All expts. showed the occurrence of concentration polarization and adsorptive fouling with a pronounced effect for the **membranes** with higher MWCO. Due to that, the 40 and 10 kDa **membranes** did not offer a significant regaining of permeate productivity. High-color and low-solids rejections were observed for all the expts., showing a marked dependence on the type of effluent used.
ST tannery wastewater decolorization ultrafiltration **polyethersulfone** **membrane**
IT **Polysulfones**, uses
 Polysulfones, uses
RL: DEV (Device component use); USES (Uses)
 (polyether-, **membranes**; ultrafiltration for color removal
 from tannery dyeing wastewaters using)
IT Polyethers, uses
 Polyethers, uses
RL: DEV (Device component use); USES (Uses)
 (**polysulfone**-, **membranes**; ultrafiltration for color
 removal from tannery dyeing wastewaters using)

IT **Tanning (curing)**
Tanning (curing)
(wastewater; **ultrafiltration** for color removal from)

L5 ANSWER 3 OF 9 CAPLUS COPYRIGHT 2004 ACS on STN
AN 1999:745777 CAPLUS
DN 131:341326
TI Treatment of an industrial effluent by reverse osmosis
AU Padilla, Antonio Perez; Tavani, Eduardo L.
CS Instituto de Investigaciones en Tecnologia Quimica (INTEQUI), Universidad
Nacional de San Luis, CONICET, San Luis, 5700, Argent.
SO Desalination (1999), 126(1-3), 219-226
CODEN: DSLNAH; ISSN: 0011-9164
PB Elsevier Science B.V.
DT Journal
LA English
AB The treatment of **tanning** wastewater was studied by means of reverse osmosis and **ultrafiltration**. Tests were carried out on laboratory scale using **membranes** of polyamide (reverse osmosis) and of **polysulfone (ultrafiltration)**. The evaluation of the system was performed by chemical anal., pH measurements and visible spectrophotometry. Effects of the protein contained in the industrial effluent, the applied pressure and the feed temperature on the permeate flux were analyzed. The polyamide **membrane** used allowed us to obtain permeates with a low chromium (III) content (7-10 mg/L) but with appreciable amts. of SO₄⁼ (1-3 g/l), Cl⁻ (9-14 g/L) and Na⁺ (5-10 g/L). The presence of chromium (III) polymers was determined in the original effluent and in the concs. obtained by reverse osmosis. Finally, it was established that during the operation of reverse osmosis, the transport of H⁺(H₃O⁺) from the concentrate to the permeate was produced.

RE.CNT 23 THERE ARE 23 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

AB The treatment of **tanning** wastewater was studied by means of reverse osmosis and **ultrafiltration**. Tests were carried out on laboratory scale using **membranes** of polyamide (reverse osmosis) and of **polysulfone (ultrafiltration)**. The evaluation of the system was performed by chemical anal., pH measurements and visible spectrophotometry. Effects of the protein contained in the industrial effluent, the applied pressure and the feed temperature on the permeate flux were analyzed. The polyamide **membrane** used allowed us to obtain permeates with a low chromium (III) content (7-10 mg/L) but with appreciable amts. of SO₄⁼ (1-3 g/l), Cl⁻ (9-14 g/L) and Na⁺ (5-10 g/L). The presence of chromium (III) polymers was determined in the original effluent and in the concs. obtained by reverse osmosis. Finally, it was established that during the operation of reverse osmosis, the transport of H⁺(H₃O⁺) from the concentrate to the permeate was produced.

ST **tanning** wastewater **reverse osmosis** **ultrafiltration**
chromium recovery

IT Wastewater
Wastewater
(tannery; treatment of **tanning** wastewater using polyamide
membrane reverse osmosis and **polysulfone**
membrane ultrafiltration)

IT Polyamides, processes
Polysulfones, processes
RL: DEV (Device component use); PEP (Physical, engineering or chemical process); PRP (Properties); PROC (Process); USES (Uses)
(treatment of tannery effluent by reverse osmosis)

IT **Tanning (curing)**
Tanning (curing)
(wastewater; treatment of **tanning** wastewater using polyamide
membrane reverse osmosis and **polysulfone**
membrane ultrafiltration)